MULTI-CHANNEL SEARCH FOR SUPERGRAVITY AT THE LARGE HADRON COLLIDER

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ABSTRACT

The potential of seeing supersymmetry (SUSY) at the CERN Large Hadron Collider (LHC) was studied by looking at 3 types of signals: dilepton events from slepton pair productions, trilepton events from chargino/neutralino productions and missing energy plus multi-jet events from gluino/squark productions. I described my results by mapping out reachable areas in the supergravity parameter space. Areas explorable at LEP II were also mapped out for comparison.

1. Introduction

In the supergravity model (SUGRA), gauge couplings, masses of scalar fields, masses of gauginos, trilinear and bilinear soft SUSY breaking terms are assumed to unify at $M_X \sim 10^{16}$ GeV and leaves us with only five free parameters (along with m_t):

$$m_0, m_{\frac{1}{2}}, A_0, tan\beta \text{ and } sgn(\mu).$$

With one set of these parameters given, by evolving 26 renormalization group equations (RGEs) and requiring radiative electroweak symmetry breaking, particle/sparticle masses and couplings can be obtained and detailed phenomenological study can be performed.

Most of this study was done in the framework of SUGRA and the tool is ISAJET which is a Monte Carlo simulator for $pp, p\overline{p}$ and e^+e^- colliders. In the SUGRA parameter space, areas which are excluded by theories (no radiative electroweak symmetry breaking, lightest SUSY particle (LSP) not $\widetilde{Z}_1$ or tachyonic particle mass) or by experiments ($m_{\widetilde{W}_1} < 47$ GeV, $m_{\tilde{\ell}} < 45$ GeV, $m_{\tilde{\nu}} < 43$ GeV, $m_{H_\ell} < 60$ GeV and the area excluded by non-observation of an excess of $\not{E}_T$ events from gluino squark production at the Tevatron) were avoided.

2. Phenomenological overview

2.1. Dilepton events from slepton pair productions[1]

It has been shown that the main sources for this type of events are $\tilde{\ell}_R\overline{\tilde{\ell}}_R$ and $\tilde{\ell}_L\overline{\tilde{\ell}}_L$

productions and that they should be detectable up to a limit of $m_{\tilde{\ell}} \sim 200 - 250$ GeV.

2.2. Trilepton events from chargino/neutralino productions[2]

This signature comes mainly from $\widetilde{W}_1\widetilde{Z}_2$ production and can be seen if the spoiler modes ($\widetilde{Z}_2 \to \widetilde{Z}_1 H_\ell$ or $\widetilde{Z}_2 \to \widetilde{Z}_1 Z$) are not open and the interference effect in the $\widetilde{Z}_2 \to \widetilde{Z}_1 \ell\overline{\ell}$ branching ratio (which is especially noticeable when $\mu > 0$) is small. Special cuts were developed to suppress $t\overline{t}$ background which could otherwise be severe.

2.3. $\not{E}_T$ plus multi-jet events from gluino/squark productions[3]

This is the most powerful channel to see SUSY at LHC because it reaches out to a huge area in the parameter space. $m_{\tilde{g}}$ can be measured to $15 - 25\%$ by looking at hemisphere masses. Jet multiplicity may reveal informations of mass difference between the gluino and the squark.

3. Conclusions

Results of this calculation is shown in fig. 1 where I have taken $A_0 = 0$, $tan\beta = 2$ and $\mu < 0$. The brick area is excluded by theory and the slashed area is excluded by experiments. In fig. 1a, the contour labeled by $\tilde{\ell}_R(200)$ is about where we can reach in the dilepton channel. With a luminosity of $10fb^{-1}$, the reachable (5σ is our criteria) area of trilepton channel lies below the 2 spoilers when 2-body decay modes ($\widetilde{Z}_2 \to \tilde{\ell}\ell$ and $\widetilde{Z}_2 \to \tilde{\nu}\nu$) are closed. When 2-body decay modes are open, we can see this signature over the spoilers but not higher than $m_{\frac{1}{2}} = 400$ GeV. At LEP II the areas below $H_\ell(90)$ and $\widetilde{W}_1(90)$ are explorable. The $\not{E}_T(5\sigma)$ contour is spectacular in that it covers most of this parameter space. In fig. 1b mass contours of gluino and squark are plotted for comparison with 1a.

4. Acknowledgements

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5. References

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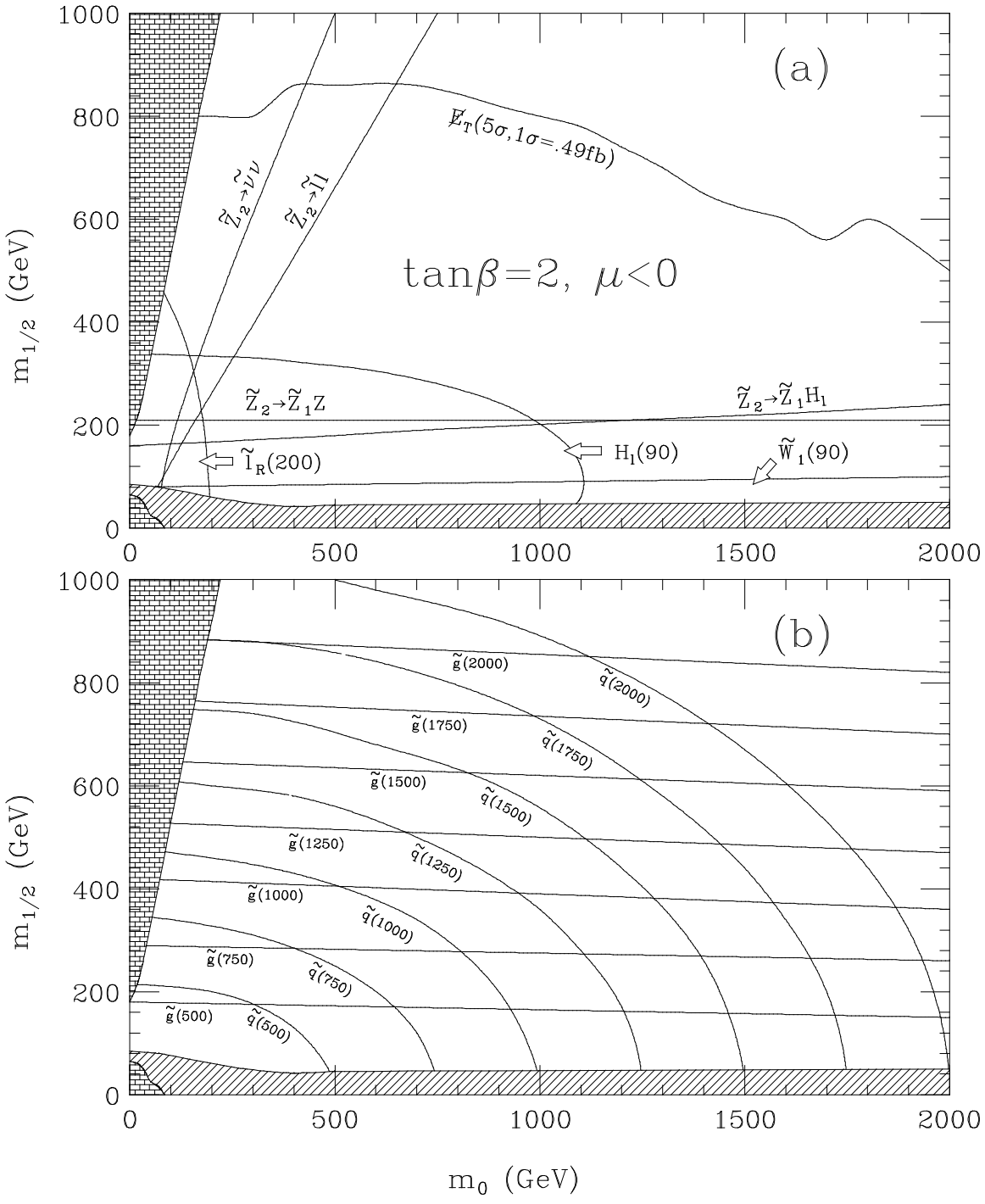

Figure 1: Explorable regions of various channels on the $m_{\frac{1}{2}}$ vs. m_0 plane. Shaded areas are excluded by theory or experiments.

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